PARKING LOT AND ROAD RUNOFF MANAGEMENT BMPS

Concrete Grid and Modular Pavement

Definition

Concrete grid and modular pavement is a pavement consisting of strong structural materials having regularly interspersed void areas that are filled with pervious materials, such as sod, gravel or sand. See Figure 10 for a Concrete Grid and Modular Pavement design in Maryland.

Purpose

The intention of concrete grid and modular pavement is to reduce water pollution from low-volume traffic areas by providing a bearing surface having adequate strength to accommodate vehicles while allowing infiltration of surface water and filtration of pollutants.

Planning Considerations

Concrete grid and modular pavement systems vary considerably in configuration (See Figure 10 and 11). Categories include:

- Poured-in-Place Concrete Grids - Reinforced concrete grids covering large areas are poured in place on the ground to be covered. Special forms are used to shape the void areas, and flat surface results. Because the slab is continually reinforced with steel, this pavement is suitable for heavy loads and has maximum resistance to movement caused by frost heave or settling.

- Pre-Cast Concrete Grids - Concrete paving units incorporating void areas are usually precast in a concrete products plant and trucked to a job site for placement on the ground. However, for large jobs these units can be formed

Figure 10 Concrete Grid and Modular Pavement at Baltimore Zoo

and cast at the site. The following are the major types of grid pavers:

1. Lattice Pavers - generally flat and grid-like in surface configuration.
2. Castellated Pavers - distinguished by a more complex surface configuration characterized by crenels and merlons that are exposed when pervious materials are added. These units show a higher percentage of grass surfaces.

- Modular Unit Pavers - Smaller pavers that may be clay bricks, granite sets, or cast concrete of various shapes. These pavers are monolithic units which do not have void areas incorporated into their configuration. They are installed on the ground to be covered with pervious material placed in the gaps between the units. The condition where concrete grid and modular pavement practice applies is where pavement is desirable or required for low-volume traffic areas and the underlying soils allow for rapid drainage. This practice is most applicable for new construction, but it can be used in existing developments to expand a parking area or even to replace existing pavement if that is a cost-effective measure. This practice should NOT be used in areas where infiltrated pollutants may reach and degrade groundwater to below state standards.

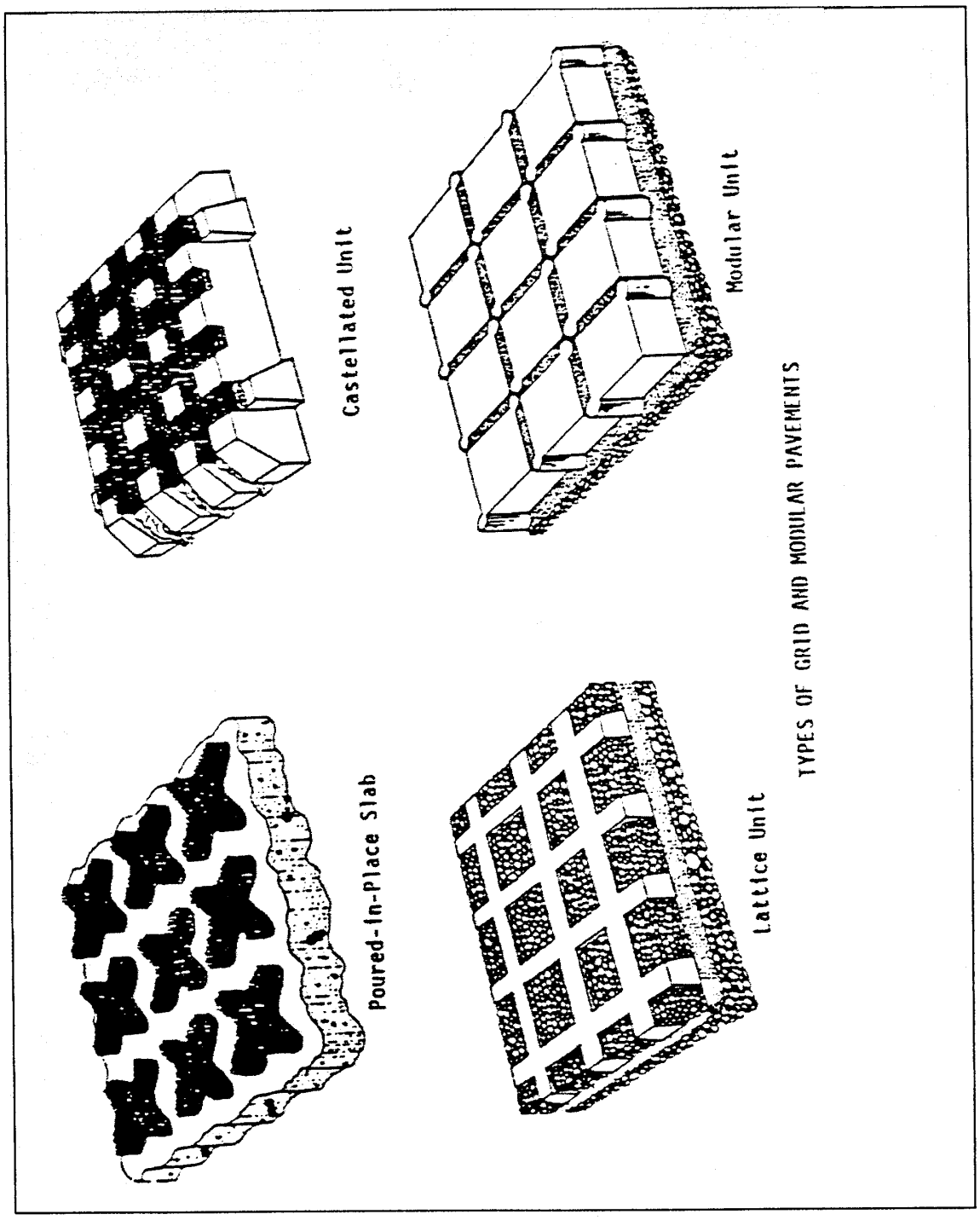


Figure 11. Types of Grid and Modular Paving

Possible areas for use of these paving materials include:

- Parking lots especially fringe or overflow parking areas.
- Parking aprons, taxiways, blast pads, and runway shoulders at airports (heavier loads may demand the use of reinforced grid systems).
- Emergency stopping and parking lanes and vehicle crossovers on divided highways.
- On-street parking aprons in residential neighborhoods.
- Recreational vehicle camping area parking pads.
- Private roads, easement service roads and fire lanes.
- Industrial storage yards and loading zones (heavier loads may demand the use of reinforced grid systems).
- Driveways for residential and light commercial use.
- Bike paths, walkways, patios and swimming pool aprons.

Production of Units - There are a number of manufacturers of precast concrete grids and unit pavers, and various styles can be purchased from distributors. Forms are required for poured-in-place systems. Contractors who have been trained in the use of the forms should install these systems.

Site Characteristics - To determine the suitability of the types of paving materials and to plan and design their installation, the following information about the site should be known:

- Environmental Data - Soil permeability and bearing capacity; slope; depth, direction of movement, natural quality, and confined or unconfined condition of groundwater; and surface drainage conditions.

- Pollution Information - Types of pollutants generated by the prevailing and intended land uses and the effect of the practice on pollutants, generally and specifically. Pollution control effectiveness is not currently documented for these products, but research into these factors is in progress and results are expected to be forthcoming.

- Intended Use of the Area - This is a key determinant of the choice of paving material. Is the installation temporary or permanent? What type of maintenance will be necessary? Is pavement coloring desired? What type of performance will be required of the paving surface? Can the practice be coupled with other BMPs for increased effectiveness?

Design Criteria and Construction Specifications - All installations of modular pavement should be designed and constructed according to the manufacturer's specifications. To be consistent with other BMP forms of treatment, the storage volume for these systems must be determined using the Maryland Unified Sizing Criteria described in the Design Manual.

With respect to water quality management, these systems must be capable of providing a storage volume for the first inch of runoff above the soil surface and including the subgrade base (if applicable), so they can also be considered to provide 90% pollutant remova1. Stored water must be perco1ated prior to the time limit specified for other onsite retention systems (72 hours). However, facilities using vegetative cover in combination with pavers must be capable of disposing of stored waters within time limits necessary to avoid damage to the ground cover (24 to 36 hours for most grasses). Parking areas should avoid extensive ponding for periods exceeding more than an hour or two.

Experience shows a definite potential for large errors in estimating the infiltration rate of the underlying soils for the purpose of evaluating the storage recovery period. Consequently, the use of a safety factor of two or more is normally recommended. This a11owance may be accomplished by reducing the percolation rate by one-half its original value or by limiting the drawdown period to half the allowable 72-hour value.

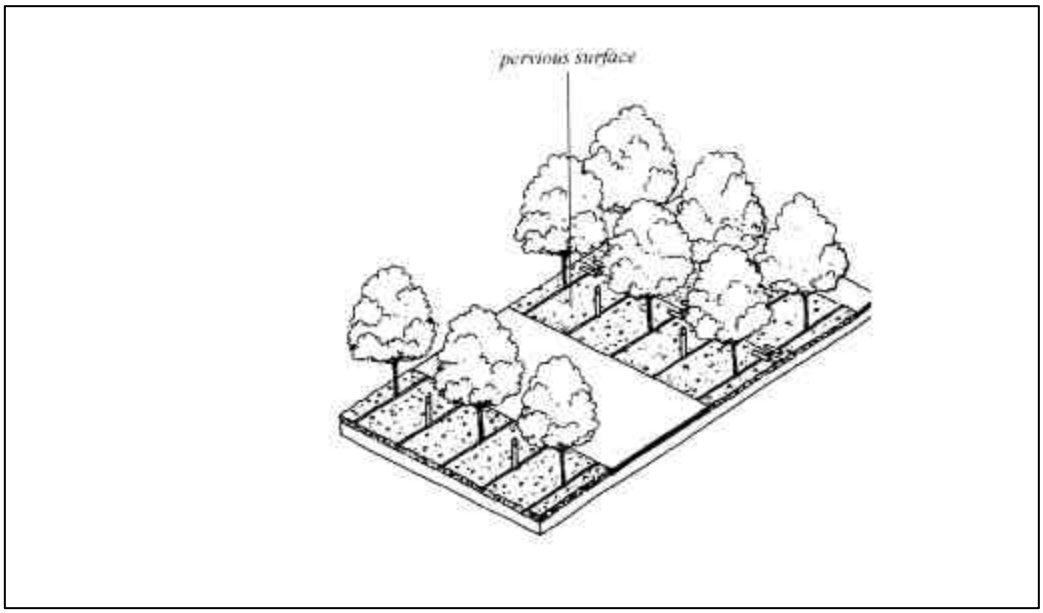
Maintenance - Where turf is incorporated into these installations, normal turf maintenance, watering, fertilizing and mowing will be necessary. Mowing is seldom required in areas of frequent traffic. It is documented that the hard surfaces in these installations require very little maintenance. However, fertilizers, pesticides and other chemicals may have adverse effects on concrete products. The use of such chemicals should be restricted as much as possible.

Special Application 1 - Parking Groves

A parking grove is a special application of concrete grids or modular paving. It consists of individual parking stalls covered with a pervious surface. The parking stalls are delimited with trees that also provide shade and increase the aesthetic value of the site. (See Figure 12)

The design characteristic of parking groves includes a variety of pervious materials that can be used in a parking grove: gravel, wood chips, or grass over a geogrid that provides stability. The material must be chosen according to the expected traffic volume and vehicle speed. The width of individual stalls needs to accommodate the width of the trees when they mature. To allow adequate space for the canopy, the trees should be planted every other stall Wooden posts or other markers may be needed as stall delimiters between the trees. Additional water storage can be provided under the pervious layer. Snow removal must be considered in the design. The native soils must have adequate drainage characteristics.

Figure 12 Parking Groves



The applicability of parking groves can be installed in any new commercial or institutional parking lots. Old parking lots can be retrofitted with parking groves.

The sources for additional information include: Richman. T. (1999), Start at the Source, prepared for Bay Area Stormwater Management Agencies Association (BAASMA), Forbes, New York

Special Application 2 - Below-Pavement Infiltration Basins

This BMP is similar to special application 1 but provides a stone layer for use as a below-pavement infiltration basin. The stone layer stores runoff that percolates through porous pavement into an underlying layer of coarse material. The water subsequently infiltrates into the natural soil. Under most circumstances, only a portion of the site is covered with porous pavement and heavy-traffic areas receive conventional pavement.

The design characteristic of below grade infiltration BMPs installed in soil below the pavement should have adequate drainage and be left uncompacted. The thickness of the storage layer depends on the volume of water that must be stored. If necessary, drainpipes may be installed to assist in draining the void space. The drainpipes lead to other BMPs. The thickness of the asphaltic layer should be selected according to the bearing capacity needs of the parking area. Using cobblestones or other pavers as markers and borders can enhance infiltration. There is a potential for failure of the porous pavement due to traffic, snow removal, or clogging with fine sediments.

The applicabi1ity of below grade infiltration BMPs is adequate for flat, 10 feet wide parking traffic areas. Porous pavement under parking bays usually needs to be

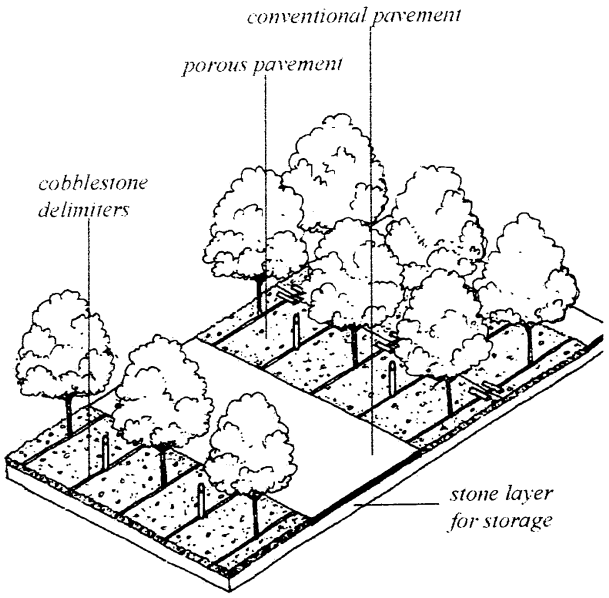


Figure 13 Below Pavement Infiltration Basins – Plan View

combined with strips of conventional pavement in high traffic areas. The BMP could be installed in parking lots, highway shoulders and pullover zones, and in parking zones along residential streets.

The sources for additional information include: Strom, S., and K Nathan (1998), Site Engineering for Landscape Architects, 3rd ed., John Wiley & Sons, Toronto, Canada.

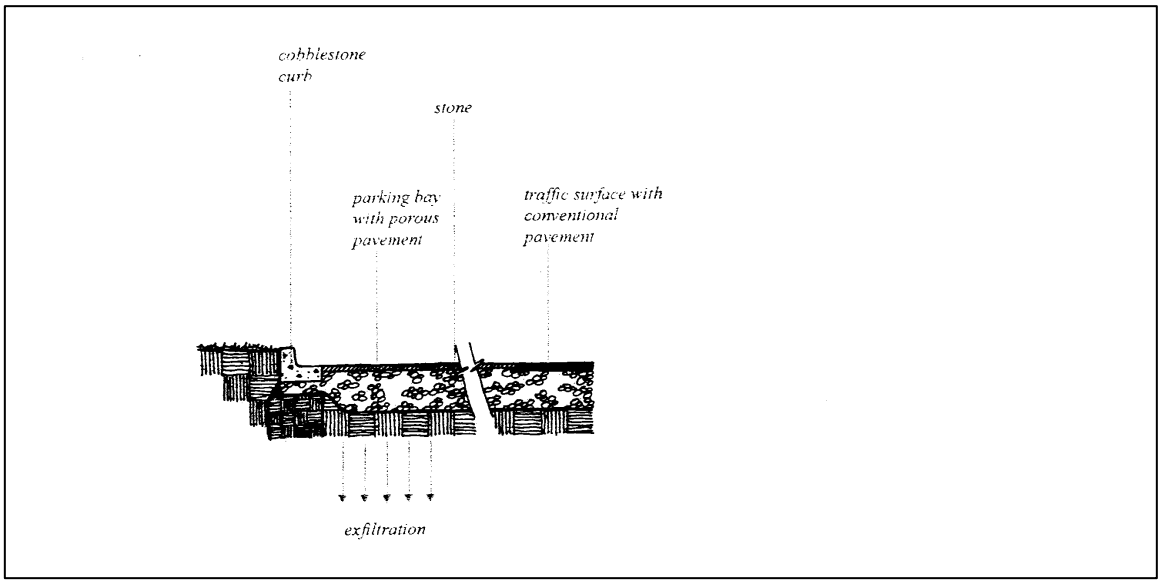


Figure 14 Below Pavement Infiltration Basins – Cross section

Parking Lot Storage

Definition

Parking lot storage provides temporary surface storage and controlled release of stormwater runoff on paved (impervious) parking areas or within parking lot landscaped islands.

Purpose

Parking lot storage reduces the adverse impact of runoff from impervious parking surfaces on receiving waters. The condition where parking lot storage applies is where portions of large, paved parking lots can be temporarily used for stormwater storage without significantly interfering with normal vehicle and pedestrian traffic. Shopping centers and large employee parking areas are likely places for use of this measure or wherever parking lot landscaped islands are required.

Design Criteria

Parking lot ponding is usually accomplished by using specifically designed or modified inlet structures, which cause stormwater to temporarily pond in specially graded areas of a parking lot.

The design criteria where parking lot storage applies:

- Increasing Storage Volume and Release Rates - Design of the storage volume and release rate is dependent upon the purpose of the system. In parking lot detention systems, the size and grade of the parking lot and the proximity of ponding areas to structures and traffic routes usually limit the storage volume. There will seldom be enough storage volume to control moderate or major flooding downstream unless additional storage volume is provided.

- Reducing Nonpoint Source Pollution - This is where a slow release rate is needed (i.e., 0.1 inch per day to 1 inch per day). Detention times in excess of 30-40 hours are most effective. Unfortunately, stormwater detention for such long periods of time may not be desirable on a parking surface. A good alternative is to design the parking lot storage system in conjunction with a subsurface retention/detention system such as infiltration trenches and/or pits. The subsurface system can be designed to collect a small initial volume of runoff while the surface ponding system can be designed to control a specific design storm at a pre-development level.

- Minimum Slope - The storage area should have at least 0.5 % percent slope toward the outlet to assure complete drainage following a storm.

- Maximum Depth - The maximum depth of water within the pond area should not exceed six (6) inches.

- Location - The portion of the parking lot where runoff storage is planned should be located so that there will be minimum interference with pedestrian and vehicular traffic during a storm. Remote perimeter areas of large parking lots are usually best suited.

- Overflow - The parking lot storage system should be designed so that overflow from storms larger than the design storm will not cause excessive damage or inconvenience. Specifically, there should be no potential for flooding of nearby buildings, major thoroughfares or other important facilities.

- Warning Sign - Ponding areas should be well marked with signs or pavement markings advising users to avoid these areas during storms in order to protect their vehicle brake linings from wetting and to prevent inconvenience to themselves.

An illustration of a typical parking lot storage system cross-section is shown in Figure 15.

Planning Consideration

Where parking lot storage applies is where paved parking areas can have a significant impact on downstream receiving waters. The impervious surface that often replaces natural vegetative cover causes increases in the volume and peak rate of runoff and also provides a place for traffic-generated residues and airborne pollutants to accumulate and become available for washoff.

The effectiveness of parking lot storage for nonpoint source pollution control can be increased by routing ponded water over infiltration areas and/or trenches. An easy way of promoting infiltration is to place raised storm sewer inlets within recessed landscaped areas. Curb cuts will allow runoff to enter the mini-retention/detention area where infiltration can occur before the stormwater rises to the elevation of the inlet.

Infiltration allows a certain amount of the ponded water to be purified by the soil. Before using infiltration techniques in conjunction with parking lot storage a determination must be made as to the possible effect upon groundwater. Other infiltration practices such as porous pavement, concrete grid and modular pavement, grassed waterways, filter strips and seepage areas can also be used in conjunction with parking lot storage to reduce nonpoint source pollution.

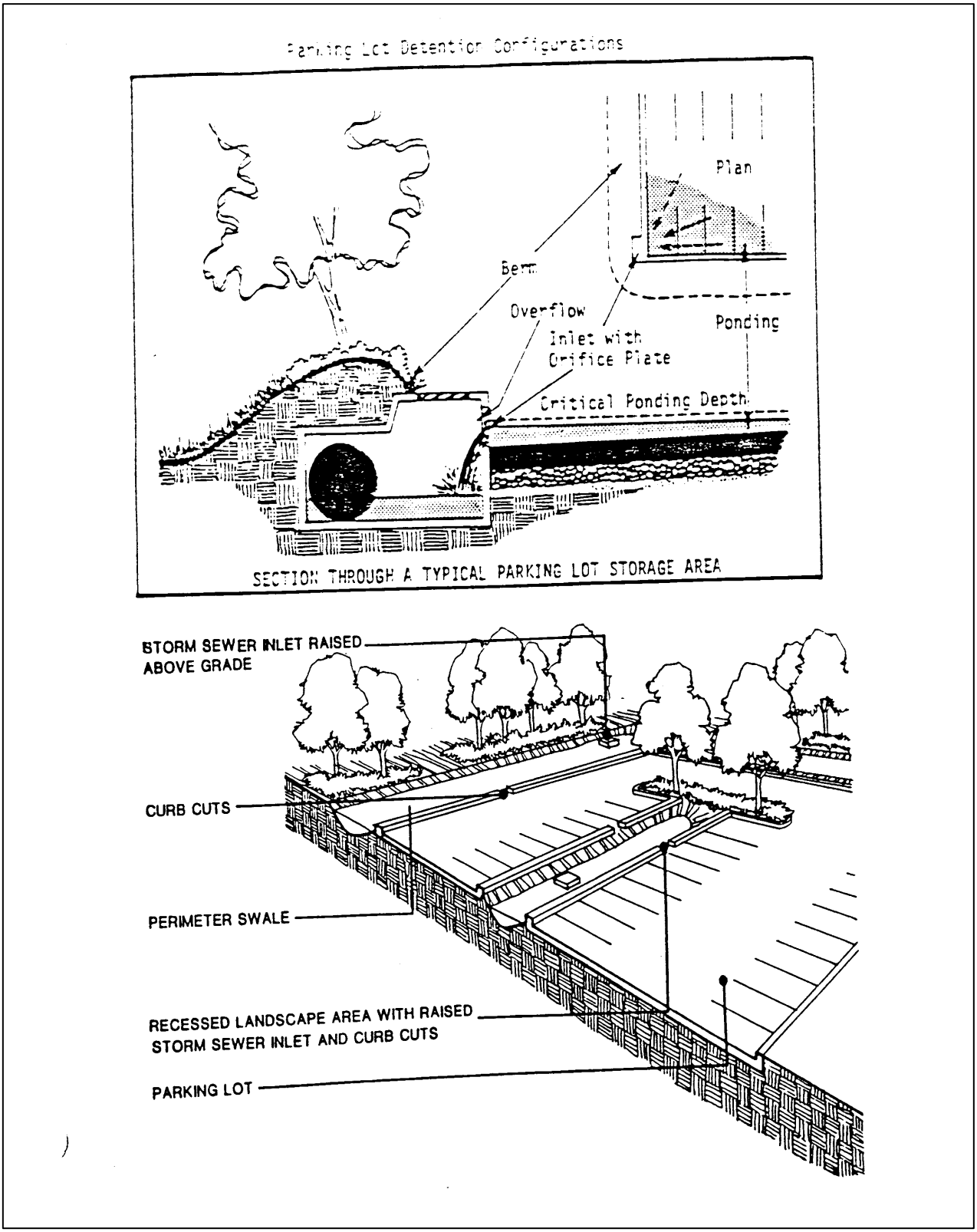


Figure 15 Parking Lot Storage

Discharge control structures should be inspected periodically and following each

storm. Accumulated debris and litter should be removed as necessary to assure proper functioning. Parking lot surfaces must be cleaned following storms to provide a reasonable level of pollution control and reduce accumulation of litter, debris, traffic-generated residues and other nonpoint source pollutants. Sweeping or vacuuming is recommended.

Bioretention Islands

Definition

Bioretention systems are flat, landscaped areas used primarily for the water quality treatment of stormwater. Water quality is improved through filtration, sedimentation, and biological processes. Figure 16 illustrates a typical bioretention island application. Bioretention systems may also be sized to meet water quantity control requirements. Bioretention can be implemented as "islands" receiving runoff from surrounding paved areas. These systems capture all of the runoff from small storms and the initial runoff from larger storms. Temporary shallow ponding occurs in these systems while the remaining stormwater flow from large storms can be bypassed or directed to other stormwater management systems. Figure 17 shows the bioretention island with a centralized stormdrain. Bioretention is an approved BMP in the Design Manual.

Design Criteria

Bioretention islands can have almost any shape but should be at least 10 feet wide, although smaller widths are used. In parking lot applications they may look like long strips between rows of parking stalls. The sites are landscaped with a variety of native water-tolerant plants including trees, shrubs and herbaceous vegetation. Runoff may need to be directed to the islands. Excess water either bypasses or flows through the facility. To reduce the possibility of clogging caused by fine sediments, stormwater can be passed through a grass filter prior to entering the bioretention area. If stormwater flows are concentrated, a dispersion trench is used to slow and spread out flows prior to entering the grass filter. However, space limitations may preclude the use of filters or dispersion trenches. Design criteria for bioretention practices are provided in the Design Manual.

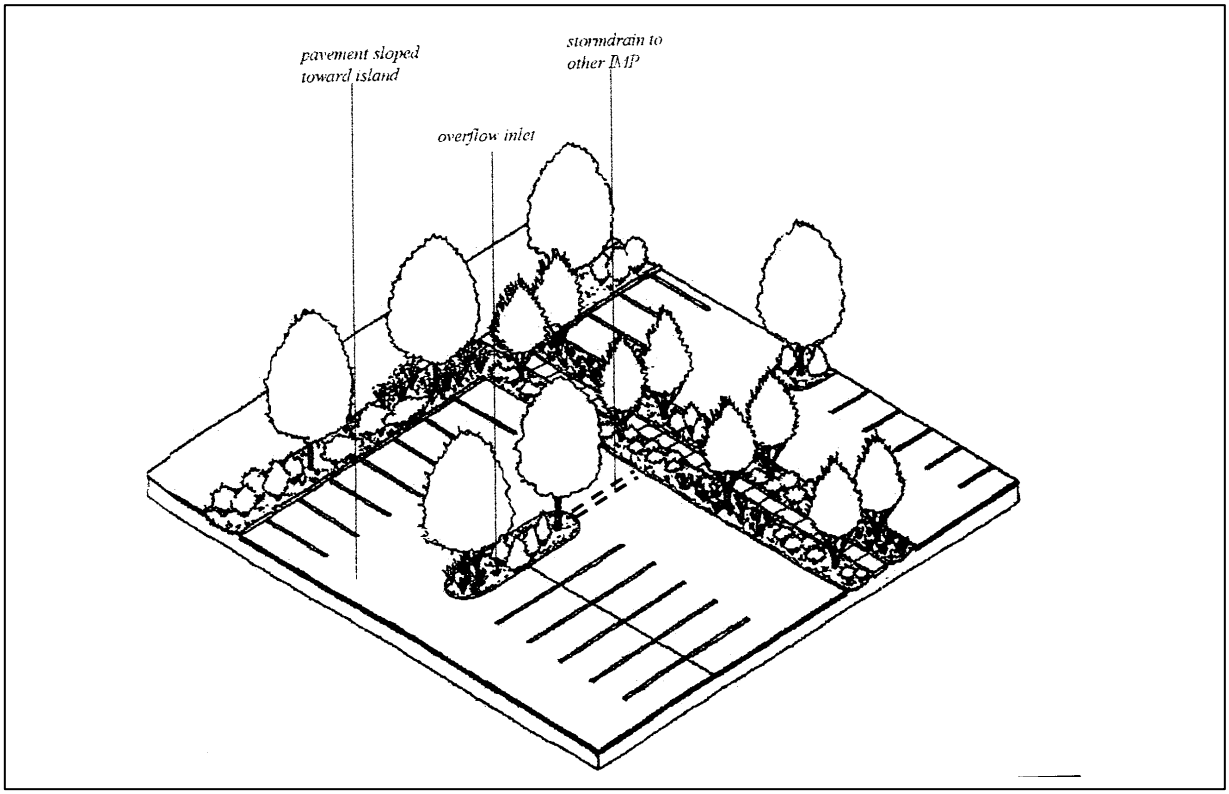


Figure 16 Bioretention Islands

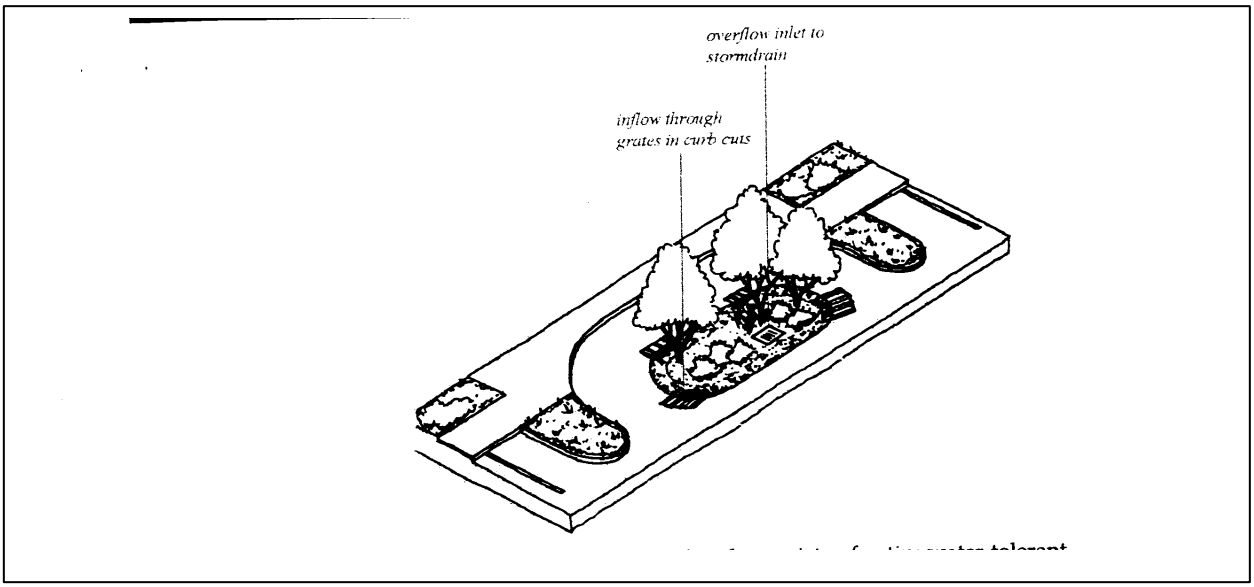


Figure 17 Bioretention Island with Storm Drain Inlet

Applicability

These types of bioretention systems can be used in almost any type of land use or in-situ soil. Bioretention islands are well suited for the retrofitting of existing development where available space is limited and grade adjustments are difficult. Where there are adverse slopes, a pipe below grade may be used to supply water to the area. The reduction in water requirements for plants in these systems eases maintenance and makes this technique particularly attractive for parking lots, street intersections, and paved areas adjacent to roads. In areas where safety may be compromised if sight lines are blocked by tall vegetation, a short ground cover can be planted.

The sources for additional information include: Prince George's County (1999), Bioretention Manual. Maryland Department of the Environment (MDE), 2000 Maryland Stormwater Design Volumes I & II.